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LAUNCH SERVICES PROGRAM

"NASA Launching your Small Satellites"

World Makers Faire
Bay Area
2015

Garrett Skrobot

ELaNa Mission Manager

Launch Services Program

NASA

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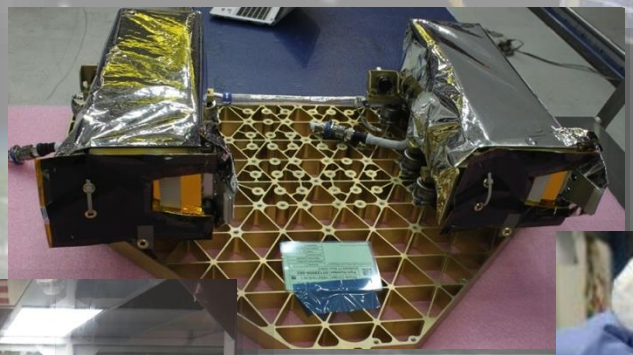
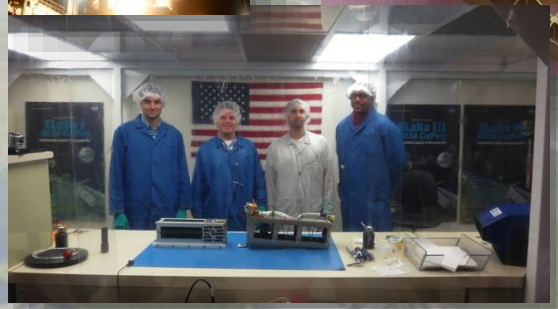
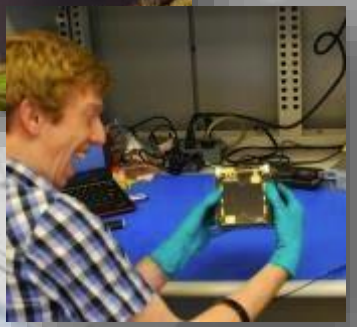
What's going on!

With the rise of the CubeSat community, secondary launch opportunities, and the maker movement, access to space has opened up to the American public in an unprecedented way.







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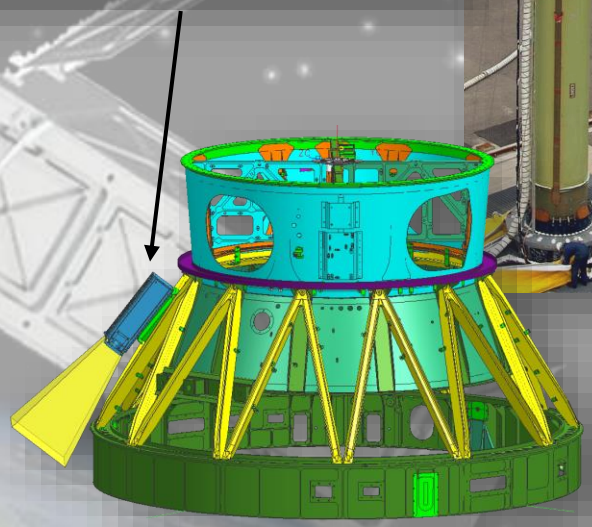
What is a CubeSat?

- A CubeSat is a type of space research nanosatellite
- The base CubeSat dimensions are 10x10x11 centimeters (one "Cube" or "1U"), or approximately four inches
- CubeSats are typically 1U, 2U, 3U, or 6U in volume and typically weigh no more than 1.33 kilogram (about 3 pounds) per 1U Cube
- CubeSats are typically low-cost, high risk-tolerant payloads
- The CubeSat will be deployed from standard deployers, system attached to the launch vehicle
- The deployers' versatile, small profile, tubular design holds three 1U CubeSats or can integrate CubeSats of different lengths (i.e., up to 3U)

CubeSat Deployer



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ELaNa Launches

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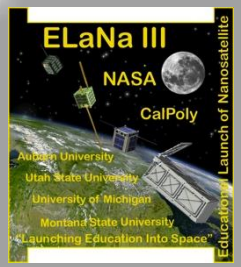
ElaNa I – GLORY

(Mar 4, 2011)

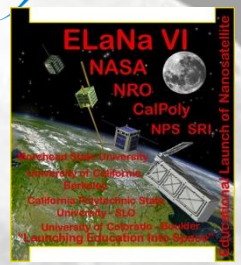
3 CubeSat Missions



ElaNa III – NPP

(Oct 28, 2011)

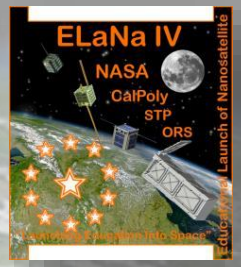
3 CubeSat Missions



ElaNa VI – L-36

(Sept 13, 2012)

3 CubeSat Missions



ElaNa IV – ORS3

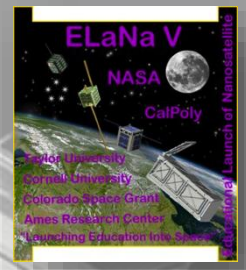
(Nov 19, 2013)

11 CubeSat Missions

ElaNa II – NROL-39

(Dec 5, 2013)

4 CubeSat Missions

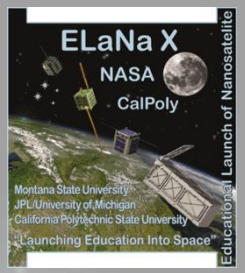


ElaNa V – CRS3

(Apr 18, 2014)

5 CubeSat Missions

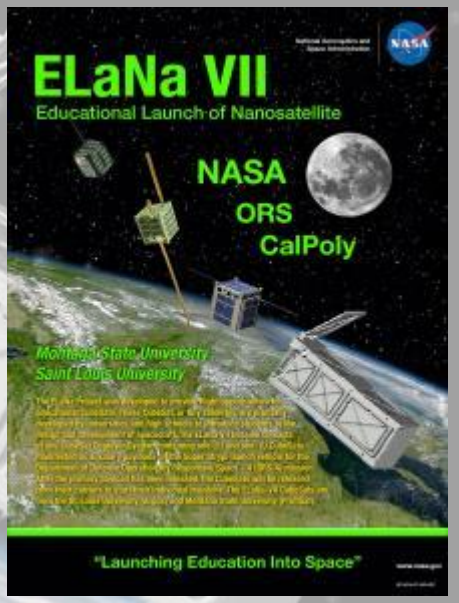
ELaNa Launches



ElaNa X – SMAP (Jan 31, 2015) 3 CubeSat Missions

NASA CubeSat Missions scheduled for launch over the next 8 months

- ELaNa XI (NET May, 2015)
  - » 1 CubeSat Missions
- ELaNa XII (NET Aug, 2015)
  - » 4 CubeSat Missions
- ELaNa VII (NET Oct, 2015)
  - » 2 CubeSat Missions
- ELaNa IX (Nov, 2015)
  - » 3 CubeSat Missions
- ELaNa XIII (NET Dec, 2015)
  - » 2 CubeSat Missions



CubeSat Missions Launched

All-Star/THEIA (Colorado)	KYSat II (Kentucky Space)	EP1–F2 (Montana)	Mcubed/COVE (Michigan)
SporeSat (AMES)	FIREBIRD-1 (Montana State University)	UNP-6 (University of Hawaii)	AubieSat (Auburn)
KickSat: (Cornell University)	Mcubed II (University of Michigan / JPL)	CAPE-2 (The University of Louisiana at Lafayette)	RAX (Michigan)
TSAT (Taylor University)	IPEX: Intelligent Payload Experiment (JPL)	Swamp Sat (University of Florida)	DICE (Utah)
PhoneSat-1 (AMES)	TJSat (Thomas Jefferson High School)	SPA-1 Trailblazer (University of New Mexico)	EP1–F1 (Montana),
Lunar Orbiter/Lander CubeSat (Vermont Technical College)	PhoneSat-2 (AMES)	HERMES (Colorado)	KYSat (Kentucky Space)
ChargerSat – 1 (UAH)	DragonSat -1 (Drexel University)	CUNYSAT-1 (Medgar Evers College, City University of New York)	CINIMA (Califrona)
CXBN (Morehead)	CP5 (CalPoly)	CSSWE (Colorado)	FIREBIRD-2 (Montana State University)
GRIFEX (University of Michigan)	ExoCube (Cal Poly)	Copper-Cube: (St. Louis University)	Race (JPL)

Missions and Systems

- Not only are CubeSats launching on rockets, they are now being deployed off of the ISS
- LSP is taking advantage of these opportunities to place CSLI CubeSats on Orbit from the ISS
- Also a Nano-Launcher System is in work for the dedicated launch of CubeSats
  - Sept 2013 a GO launcher launch vehicle was placed on contract to launch three 3U CubeSats in late 2016
  - Venture Class Launch Services
    - » The VCLS requirement is for the launch services of U-Class satellites built off of the CubeSat form factor (10 cm x 10 cm x 10 cm) of any combination of U-Class satellites (i.e., 1U, 3U, 6U, 12U, 24U)
    - » Minimum orbital altitude of 425km at a launch inclination between 33 and 98 degrees
    - » 60 kg minimum payload mass requirement
    - » Launch NLT June 15, 2018

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CubeSat Launch Initiative

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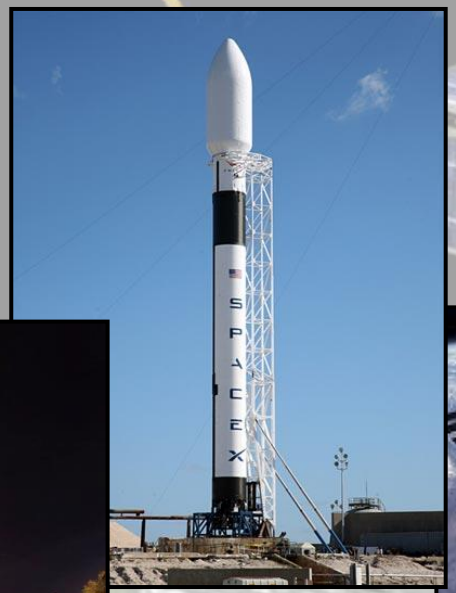
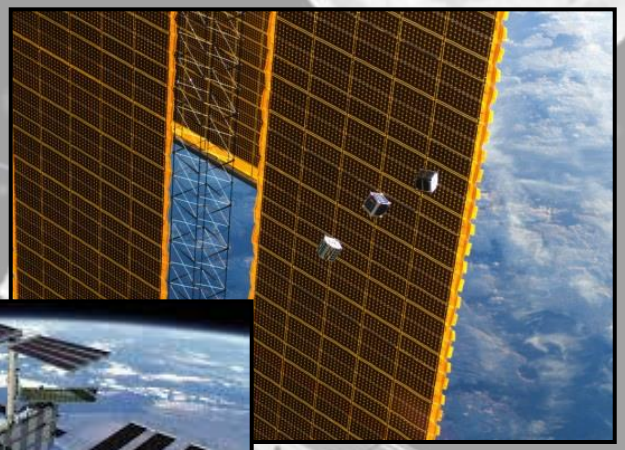
NASA's CubeSat Launch Initiative (CSLI) provides opportunities to educational and non-profit organizations to build small satellite payloads which will fly as auxiliary payloads on previously planned missions.

NASA
DoD
NRO



ISS



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CubeSat Launch Initiative

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Objective

- Provide CubeSat Launch Services on Expendable Launch Vehicles and deployments from the International Space Station to U.S. Educational Institutions, Non-profits and NASA Centers.

Aligned to NASA's Strategic Plan

- Strategic Goal 1: Expand the frontiers of knowledge, capability, and opportunity in space.
  - *Objective 1.7*: Transform NASA missions and advance the Nation's capabilities by maturing crosscutting innovative space technologies.
- Strategic Goal 2: Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.
  - *Objective 2.3*: Optimize Agency technology investments, foster open innovation, and facilitate technology infusion, ensuring the greatest national benefit.
  - *Objective 2.4*: Advance the Nation's STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA's missions and unique assets.

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ISS Deployment

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How It Works?

NASA Announcement of Opportunity

- NASA solicits proposals through an Announcement of Opportunity (AO)
- Educational Organizations, Non-Profits and NASA Centers submit proposed CubeSat Missions in response to AO

NASA Review

- A NASA Selection Committee made up of members of HEOMD (including the Launch Services Program), Space Technology Mission Directorate, Science Mission Directorate, and Education reviews proposals
- Selection Committee makes final recommendations on CubeSats
- NASA announces selection recommendations

Selectees Develop/Design/Build CubeSat

- Selectee builds satellite
- Selectee raises all funds necessary for satellite construction
- Selectee provides NASA completed satellite for integration for launch

NASA Assigns CubeSats to Manifested Launches

- NASA manifests CubeSat on available flights using excess lift capacity
- Cooperative Research and Development Agreement executed by NASA

How It Works?

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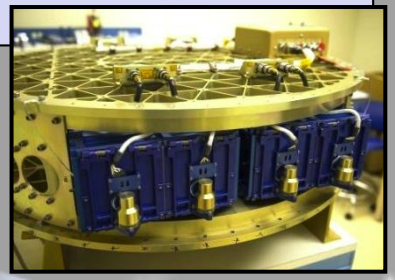
CubeSats are Developed/Designed/Bui

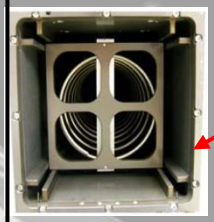
CubeSats are placed in P-POD

P-POD is integrated on the Launch Vehicle

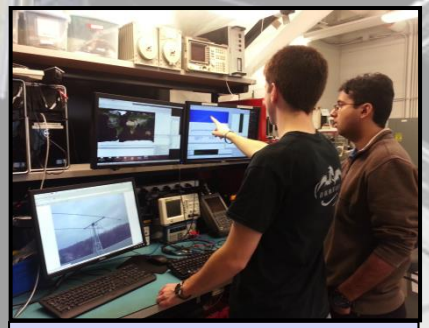


Mission Launches

Deployment spring and pusher plate



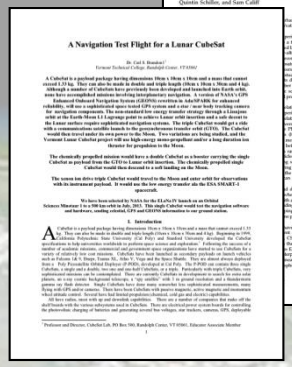
Signal Sent to LV, spring-loaded door is open, CubeSats deployed



Students or Center track and operate CubeSat from Ground Station

CubeSat burns up on re-entry after completion of mission

Small Mission Accomplished by Students—Big Impact on Space Weather Research



A Navigation Test Flight for a Lunar CubeSat

Students or Center analyze data, write technical papers, provide results and data to NASA

CSLI Benefits

Benefit to Educational Organizations and Non-profits:

- Enables students, teachers and faculty to obtain hands-on flight hardware development experience
- Advances the development of technologies
- Provides mechanism to conduct scientific research in the space environment
- Provides meaningful aerospace and Science, Technology, Engineering and Mathematics (STEM) educational experience

Benefit to NASA:

- Promotes and develops innovative public-private partnerships
- Provides a mechanism for low-cost technology development and scientific research
- Enables the acceleration of flight-qualified technology assisting NASA in raising the Technology Readiness Levels (TRLs)
- Strengthens NASA and the Nation's future STEM workforce

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Missions Examples

CSSWE

University of Colorado – Boulder, Co.

- Measure the directional flux of Solar Energetic Protons (SEPs) and Earth's radiation belt electrons in support of NASA's Radiation Belt Storm Probe Mission
- Space Weather - Heliophysics
- Payload: Relativistic Electrons and Proton Telescope

GOAL: Understand the relationship between SEPs flares and coronal mass ejections

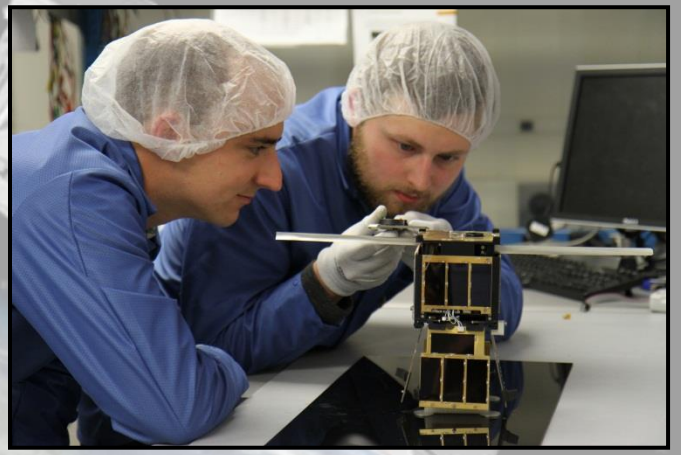
KySat-2

University of Kentucky – Lexington, KY

Morehead State University – Morehead, KY

- Test components of a novel attitude determination system called a Stellar Gyroscope that uses sequences of digital pictures

GOAL: Determine the three-axis rotation rate of the satellite



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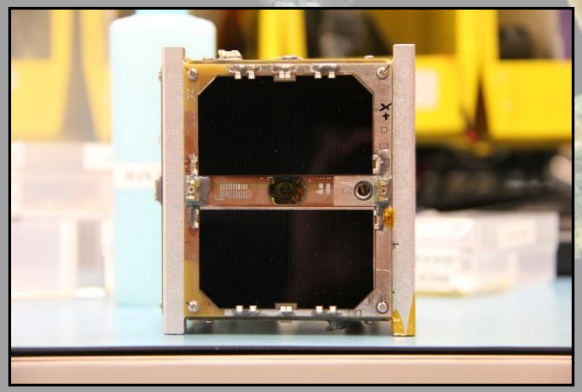
Missions Examples



M-Cubed
University of Michigan – Ann Arbor, MI

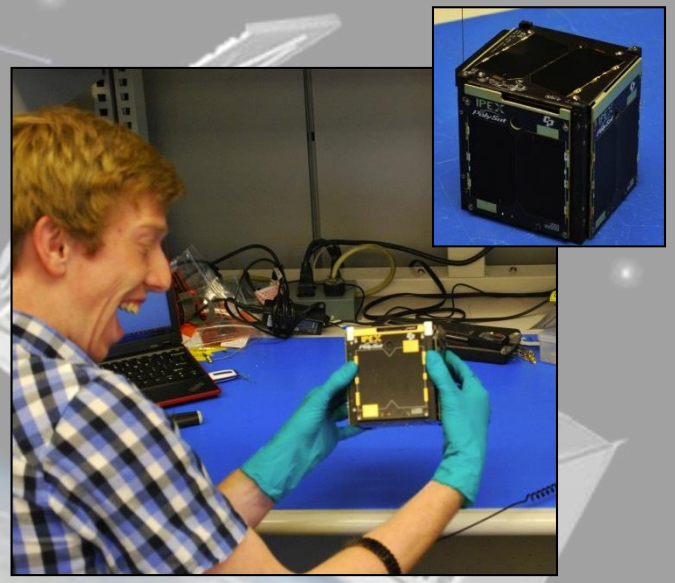
- Obtain mid-resolution imagery of the Earth's surface and carry the JPL/Caltech CubeSat On-board processing Validation Experiment (COVE)

GOAL: COVE will advance technology required for real-time, high data-rate instrument process for future Earth Science

IPEX
JPL/Cal Poly – Pasadena, CA

- Demonstrate Intelligent Payload Module (IPM) technologies including autonomous onboard instrument processing, downlink operations, and automated ground operations

GOAL: Validate IPM technologies which is a baseline for the HyspIRI Decadal Survey Mission



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Feedback

"The ELaNa program has been a game changing event for our research center. It has allowed us to be able to show past performance in the areas of nanosatellite development. This achievement has easily resulted in over $1M in future research projects for the University of New Mexico."

Craig Kief – TrailBlazer
Deputy Director
Configurable Space Microsystems Innovations & Applications Center (COSMIAC)

"Universal, location-independent service is a distinguishing feature of satellite technology. In that spirit, this NASA launch has afforded for our students, here in Louisiana, the same access to this high-technology areas as anyone else anywhere in the nation, and indeed around the world."

George Thomas – CAPE-2
Professor of Electrical and Computer Engineering
University of Louisiana, Lafayette

"The NASA ELaNa program provides an educational experience for the student team that can not otherwise be duplicated in a University setting. Students go from concepts on paper to operating their hardware on-orbit and the lessons learned between those two points is invaluable."

Professor James Lumpp – KYSat-2
Electrical and Computer Engineering, University of Kentucky

Mission Schedule

CubeSat Mission	Primary Mission	Launch Date	PPODs	CubeSats
ELaNa-I	Glory	Mar 4, 2011	1	3
ELaNa-II	NROL-39*	Dec 5, 2013	2	4
ELaNa-III	NPP	Oct 28, 2011	3	5
ELaNa-IV	ORS-3*	Nov 19, 2013	4	11
ELaNa-V	CRS SpX-3	Mar 16, 2014	4	5
ELaNa-VI	NROL-36*	Sep 13, 2012	3	4
ELaNa-VII	ORS-4*	Oct 1, 2015	1	2
ELaNa-VIII	ORB-3	FY 2014	Nanoracks	1
ELaNa-IX	ORB-4	FY 2015	Nanoracks	3
ELaNa-X	SMAP	Jan 31, 2015	3	3
ELaNa-XI	AFSPC-5*	May 2015	2	2
ELaNa-XII	NROL-55*	Aug 2015	2	5
ELaNa	ICESat II	FY 2017	3	
ELaNa	JPSS-1	FY 2017	3	
				48

* Consistent with the National Space Policy of 2010, NASA has agreements with the national security space community to leverage our respective launch capabilities.

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Announcement of Flight Opportunity

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Release Date: ~August, 2015

Response Date: Mid to Late November, 2015

Last Years site -
https://prod.nais.nasa.gov/cgibin/eps/synopsis.cgi?acqid=161828

Objective

NASA Human Exploration and Operations Mission Directorate is anticipates making launch opportunities for a limited number of CubeSats on launches or deployed from the ISS currently planned for 2016-2019.

NASA will provide integration and other services as necessary to complete the launch activity.

NASA will not transfer any funds to collaborators under Agreements negotiated in response to this Announcement.

Payload Eligibility

Benefit to NASA

Investigation must demonstrate a benefit to NASA by addressing goals and objectives of the NASA Strategic Plan and/or the NASA Education Vision and Goals.

Merit Review

Prior to submission each CubeSat investigation must have passed an intrinsic merit review. In the review, goals and objectives of the proposed investigation must be assessed to determine scientific, educational or technical quality of the investigation.

Feasibility Review

Prior to submission, each CubeSat investigation must have passed a feasibility review in which the technical implementation, including feasibility, resiliency, risk and probability of success, was assessed.

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White House Maker Initiative

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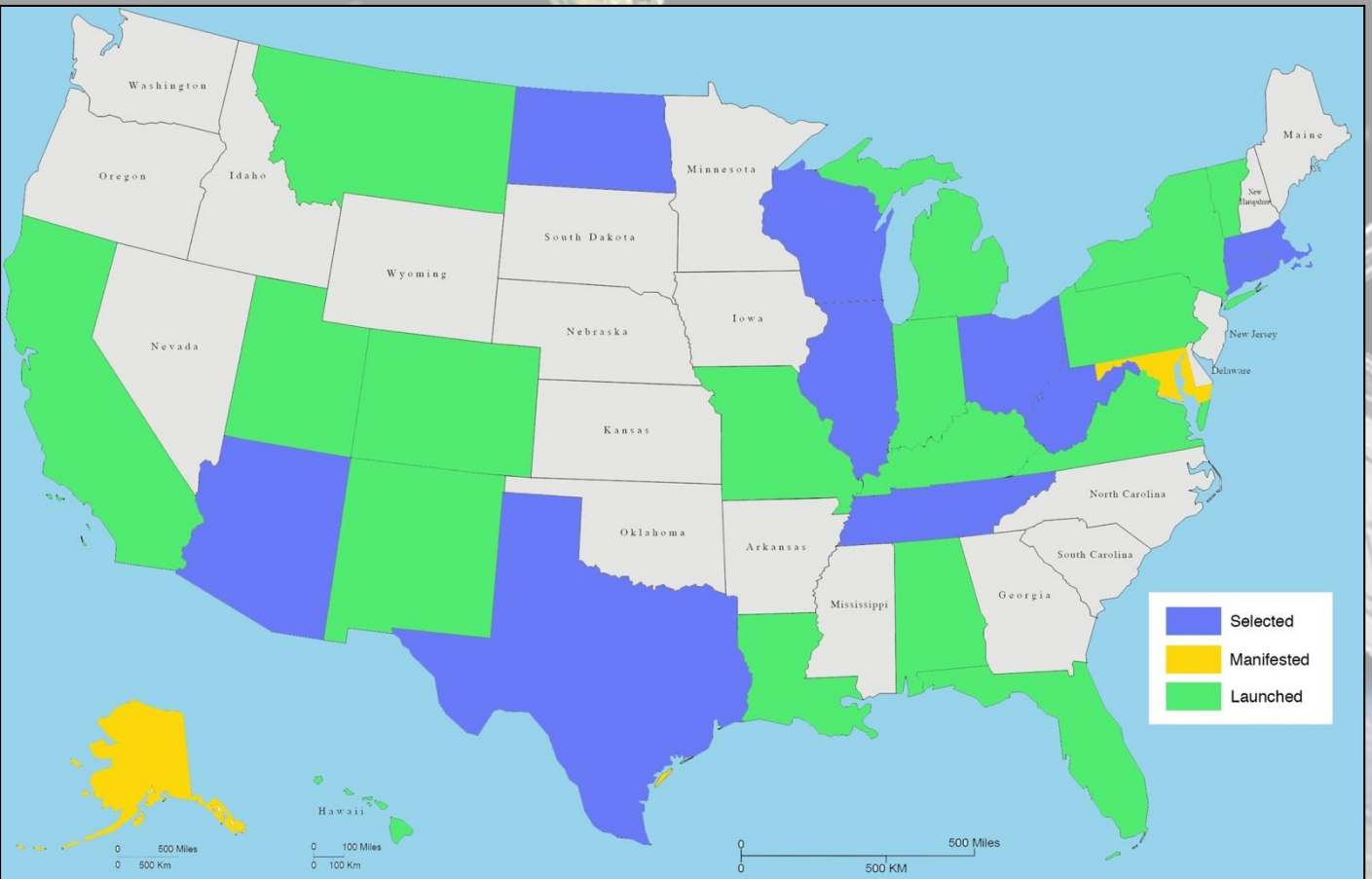
Goal to broaden NASA's CubeSat Launch Initiative to reach all states by targeting the 20 "rookie states" that have had no previous presence in space.



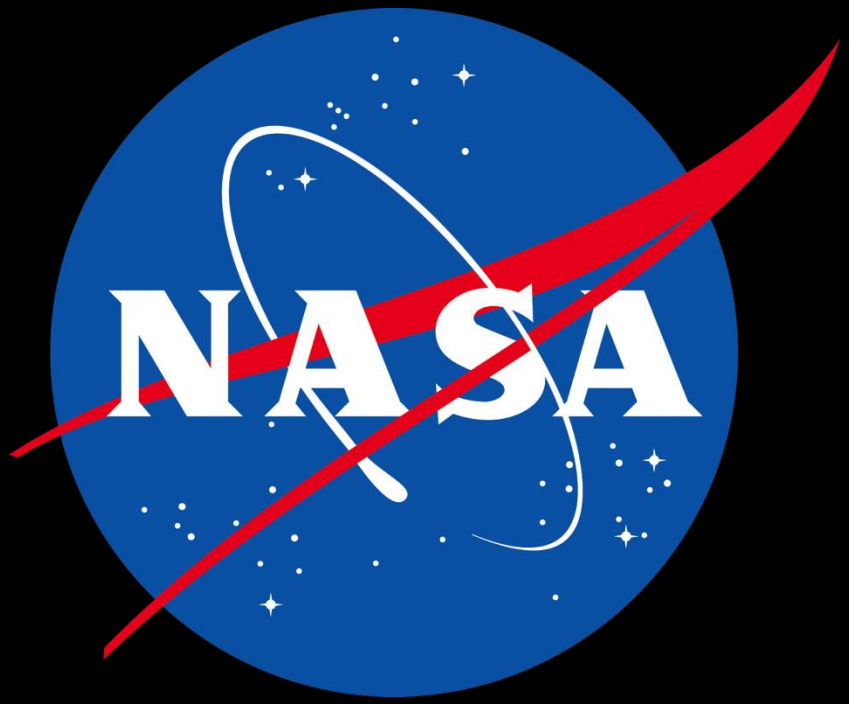
Previous CubeSat Launch Initiative selectees are encouraged to partner with, and / or mentor, organizations from these states.

"will leverage the existing NASA Space Grant network of colleges and universities."

~ White House Maker Faire Fact Sheet

Summary

- Launched 36 CubeSats to date as ELaNa missions
- Plans for 12 ELaNa missions over the next 8 months
- New CubeSat Launch Initiative Call released in August for proposals
- CubeSat Launch Initiative: 50 CubeSats from 50 States in 5 years
- Working to get Rookie States Selected
- Challenges


NASA